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# Locking Plate Fixators for Infected Extra-articular Long Bone Fractures without Bone Loss

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**Learning Point of the Article:**

Use of locking plates in infected non union of long bones.


## Abstract

**Introduction:** Management of infected extra-articular long bone fractures without bone loss remains a challenging orthopedic problem. Traditional methods involving external fixators can be associated with discomfort, pin site infections, and delayed union. Supercutaneous plating using metaphyseal locking plates offers a promising alternative. To evaluate the clinical and radiological outcomes of locking plate fixators as a definitive treatment for infected extra-articular tibial and femoral fractures without bone loss.

**Materials and Methods:** This prospective study included 15 patients treated between February 2018 and November 2019 at a tertiary care center. Inclusion criteria were extra-articular fractures without bone loss or intra-articular extension, and adequate wound management feasibility. All patients underwent thorough debridement and fixation using metaphyseal locking plates as external fixators following external fixator principles. Antibiotics were tailored based on intraoperative cultures and administered for 6 weeks. Patients were followed clinically and radiographically for fracture healing, complications, and functional outcome using the Knee Society score.

**Results:** Of the 15 patients, 4 had distal femur fractures and 11 had tibial fractures. The mean follow-up was 9 months. Average union time was 8 months for femur and 3.9 months for tibia fractures. Two patients required autologous iliac crest bone grafting. Functional outcomes were excellent in 4 patients (26.6%), good in 7 (46.6%), fair in 3 (20%), and poor in 1 (6.7%), with all suboptimal outcomes noted in femur fractures. Six patients experienced screw tract infections, and one had a refracture following premature plate removal. No implant failure or loosening was observed.

**Conclusion:** Metaphyseal locking plate fixators can be effectively used as a definitive fixation method for infected extra-articular fractures without bone loss. The technique provides stable fixation, acceptable infection control, and promotes union with good patient compliance. Larger prospective studies are required to confirm these promising outcomes.


**Keywords:** Locking plate fixator, supercutaneous plating, infected fractures, tibia, femur.

## Introduction

Management of open fractures is a surgical urgency comprising debridement of devitalized and contaminated tissues, stabilization of fractured bones, and timely administration of appropriate antibiotics [1, 2]. Achieving fracture union and optimum function may involve multiple surgeries depending on the extent of contamination, bone and soft-tissue loss, and development of complications. The initial procedure is the key, as an adequate debridement substantially reduces the risk of development of infection and must be performed by an

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**Figure 1:** Case 1- pre-op X-rays.

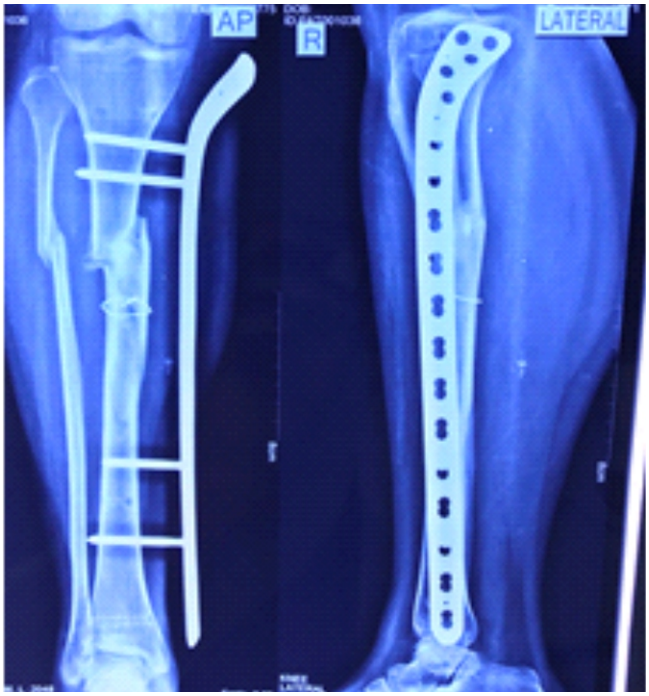


**Figure 2:** Case 1 – post-operative X-rays showing radiological union.

experienced team [2].

Delayed presenting open fractures are complex problems, as the golden opportunity of early debridement and fracture stabilization has already been missed, and it is not infrequent for the infection to have been established by the time of any surgical intervention in most cases. Similarly, inadequate initial debridement, failure to recognize the necessity of subsequent serial debridements, or poor care of external fixator pins can lead to persistent infection, thereby making the subsequent treatment difficult. Although the principles of management remain the same as for open fractures, the overall risk of chronic osteomyelitis and fracture nonunion is increased in such cases. In these patients, the goal of treatment is to eradicate the infection and to achieve fracture union with optimum limb function.

Initial fracture stabilization can be done as a temporary measure with an external fixator or internal fixation with an antibiotic-coated implant or antibiotic-impregnated cement spacer till the infection subsides; this can be followed by an exchange to a better definitive fixation device. Otherwise, an external fixation system can be used as a definitive modality (Ilizarov ring fixator and monorail system) [3]. The second strategy is useful in cases with bone loss [4, 5]. Either strategy has its advantages and disadvantages. However, irrespective of the approach adopted, the overall cost of treatment and the patient's tolerability are always important considerations.

In our own experience with delayed presenting cases with established infection, we have had a very high incidence of persistent infection leading to chronic osteomyelitis when internal fixation was used following initial debridement, even when performed as a staged procedure.

A locking compression plate (LCP) used as an external fixator (supercutaneous plating) has produced satisfactory outcomes in open/closed tibial fractures and infected nonunion of the tibia, clavicle, and humerus, overcoming the shortcomings of traditional external fixators [6, 7, 8, 9, 10, 11, 12, 13]. It has the advantages of being located on one side of the limb, being easier to apply, and being less bulky, leading to greater patient tolerability [8, 9]. The purpose of this study was to evaluate the functional and radiological outcomes of treatment of delayed presenting open extra-articular lower limb fractures complicated with infection using locking plate external fixators as a definitive fixation modality.

## Materials and Methods

This prospective study was conducted between February 2018 and November 2019 after obtaining approval from the departmental review board at our institute, which is a tertiary care referral center. Informed consent was obtained from all patients before inclusion.

### Inclusion criteria

Patients were included if they had been primarily managed at

**Figure 3:** Case 1 – post-operative range of motion achieved.

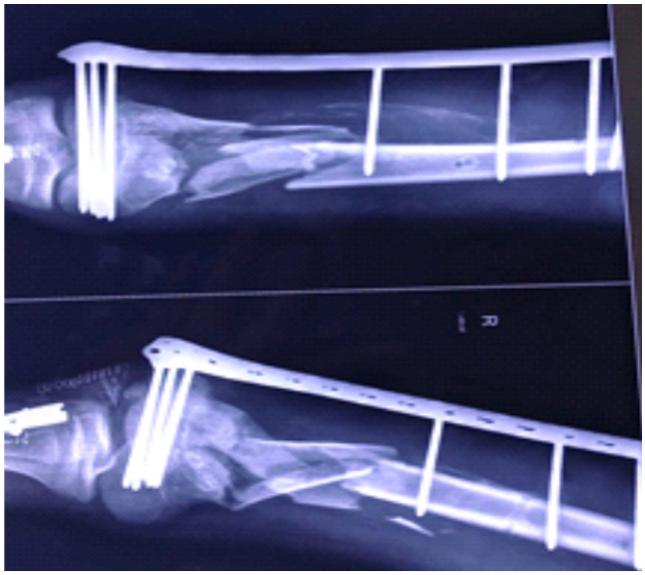

**Figure 4:** Immediate case 2 post-operative X-rays.

another hospital and were referred to or presented independently at our institute. Inclusion required the absence of intra-articular extension, no bone loss necessitating bone transport, and the planned plate position not interfering with wound management.

### Pre-operative and surgical procedure

No pre-operative antibiotics were administered. Under spinal anesthesia, thorough debridement of the infected open wound was performed. Multiple deep intraoperative cultures were taken. In simple fractures, bone ends were trimmed to achieve at least 50% apposition. In comminuted or segmental fractures, all viable bone fragments with attached soft tissue were retained after adequate debridement. For tibial fractures, a stainless steel 4.5 mm proximal tibial metaphyseal plate was applied to the anteromedial surface (Fig. 1). For femoral fractures, a distal femoral metaphyseal plate was applied to the lateral surface. External fixator principles were followed, using long plates and bicortical screws. Temporary stabilization with K-wires was achieved before definitive plate application. A one-finger breadth distance was maintained between the plate and the skin. A minimum of three screws were placed in the longer fragment and four in the shorter fragment, with the most proximal and distal screws applied first to ensure correct plate positioning. For femoral applications, cruciate incisions were made in the iliotibial band around the screws to prevent tethering during knee flexion. In seven cases, reused plates were applied after autoclaving; however, fresh screws were used in all cases.

### Post-operative management

Antibiotics were administered according to culture and sensitivity reports for a total of 6 weeks – 2 weeks of intravenous antibiotics followed by 4 weeks of oral antibiotics. Wound care involved daily dressing with normal saline until healing was complete. Screw tracks were cleaned daily with normal saline during hospitalization. Among the cohort, only one patient with a proximal tibial fracture required a split-thickness skin graft to cover a wound defect on the lateral upper third of the leg. No other patients required flap procedures. Upon discharge, patients were educated on wound care and hygiene. Once complete wound healing was confirmed, patients were allowed to shower with the external fixator in place. Supervised physical therapy using a continuous passive motion (CPM) machine was initiated on post-operative day 2 and continued throughout hospitalization. Depending on the stability of fixation, toe-touch or partial weight-bearing was encouraged from 4 to 6 weeks postoperatively.

### Follow-up and outcome measures

Between 6 and 12 weeks, plate dynamization was performed by removing a screw near the fracture site to promote progressive weight-bearing as healing advanced. Plate removal was conducted in the outpatient setting on radiological confirmation of fracture union (Fig. 2). Follow-up assessments included anteroposterior (AP) and lateral radiographs at 6 weeks, 3 months, and every 6–8 weeks thereafter until fracture union. An orthoscanogram (bilateral lower limb AP view) was performed after plate removal to assess coronal plane alignment. Lack of fracture callus at 12 weeks was an indication for autologous bone grafting. Functional outcomes were evaluated using the Knee

**Figure 5:** Case 2 follow up X-rays showing radiological union.

Society score 2 weeks after plate removal (Fig. 3). Screw track infection was diagnosed clinically by the presence of increased pain, redness, and purulent discharge around the screw site.

## Results

A total of 15 patients underwent cutaneous plating of the tibia and femur fractures using a metaphyseal locking plate (Figs. 4 and 5). Table 1 summarizes the patient data. All patients were followed for a mean of 9 months (range 6–12 months). The time between injury and definitive surgery was 1.4 months (range 15 days to 5 months). At presentation, all of them had an active purulent discharge from the wound over the fracture site with pin tract infection in patients with an external fixator.

Four patients requiring this procedure had distal femur fractures, and the rest 11 patients had tibia fractures. The average union time was 8 months in the distal femur group (Fig. 6) and 3.9 months in the tibia group. Two patients (one each with femur and tibia fractures) needed an autologous iliac crest bone graft to augment the fracture union (Table 1).

**Figure 6:** Case 2 – post-operative X-rays after implant removal – lateral.

The knee society score was excellent in 4 (26.6%), good in 7 patients (46.66%), fair in 3 (20%), and poor in 1 (6.67%) patient; the details are summarized in Table 2. All patients with a fair or poor score had a distal femur fracture (Fig. 7).

In three patients, the infection-causing microorganism (Escherichia coli) was resistant to all tested antibiotics except cotrimoxazole. In two of them, the infection subsided with another debridement within a week. The third patient underwent a 3rd debridement to eradicate the infection.

Six patients had a screw tract infection at some point during the treatment (12 incidences). Swabs were taken for microbiological analysis. They were treated with regular dressing and local ciprofloxacin eye drop application with a course of appropriate intravenous or oral antibiotics. The painful screws were removed if the fracture showed signs of healing and the overall stability of the construct was adequate. No loosening or failure of the implant was observed in any patient. One patient (distal femur group) had shortening of 5 cm as compared to the contralateral limb post repeated debridement and was prescribed a shoe raise for ambulation. One patient developed a repeat fracture 2 weeks after plate removal. A review of the radiographs just before plate removal showed that the callus formation was deficient on one side. As the fracture was incomplete, it was treated with a high groin cast, and the fracture finally healed in 2 months. Table 2 presents the details of the complications encountered in the course of treatment.

**Figure 7:** Case 2 – post-operative range of motion achieved.

**Table 1: Patient demography and diagnosis**

| Serial number | Age | Sex | Diagnosis | Associated injury | Primary surgery | Time for second surgery |
|---|---|---|---|---|---|---|
| 1 | 13 | M | #proximal tibia with distal both bone leg | Nil | CRIF with tens nail | 5 months |
| 2 | 29 | M | #proximal 1/3 both bone leg | Ipsilateral #femur | Exfix | 1 month |
| 3 | 29 | F | #Proximal both bone leg | Nil | Exfix with cercelage | 2 month |
| 4 | 16 | M | segmental comminuted lower third femur fracture | Both bone leg | Exfix with antibiotic beads | 1 month |
| 5 | 34 | M | #distal femur | Nil | Exfix | 1 month |
| 6 | 10 | F | proximal tibia | Nil | Exfix | 2 weeks |
| 7 | 27 | M | # Both bone leg | Opposite side #patella | Exfix | 1 month |
| 8 | 27 | M | #proximal tibia | Nil | Exfix | 1 month |
| 9 | 15 | F | #proximal tibia | Ipsilateral #patella | Exfix with antibiotic beads | 1 1/2 months |
| 10 | 28 | M | # proximal Tibia | Nil | Exfix | 1 month |
| 11 | 35 | M | #distal femur | Nil | Exfix | 1 1/2 month |
| 12 | 24 | M | #Both bone leg | Nil | Exfix | 1 month |
| 13 | 12 | M | #proximal tibia | nil | Exfix | 1 month |
| 14 | 30 | F | #bothbone leg | Nil | Exfix | 1 1/2 month |
| 15 | 40 | M | #distal femur | Nil | Exfix with antibiotic beads | 1 month |

## Discussion

Since its first description by Kloen [6], many authors have described the use of LCPs as an external fixator. Although the plates are not designed to be used in this manner, the ease of application, low complication rates, and the predictable outcome have enhanced their acceptability among orthopedic surgeons. Our study shows that using locking plates for external fixation is a suitable option for treating patients with open long bone fractures with established infection who have presented late. The bony union is predictable if a good fracture apposition can be achieved along with eradication of infection, which may need serial debridement. Previous studies have shown that external locked plate fixation can be a feasible option for definitive treatment of tibia fractures from a biomechanical viewpoint [11, 14, 15]. These findings have been reciprocated in multiple clinical studies with satisfactory radiological outcomes [8, 9, 10, 12, 16]. In 7 proximal tibia fractures, we used a proximal tibial metaphyseal plate. Ma et al. advocated the use of a femoral metaphyseal plate for proximal tibial fractures as it is relatively straight [11]. Although we did not have any difficulty in screw positioning due to the proximal curvature of the plate, as the proximal tibia is wide enough. For distal femur fractures, we used a femoral metaphyseal plate.

In distal femur fractures, because of limited bone in the distal fragment, only a ring fixator can provide adequate multiplanar stability without spanning the knee joint until the union is achieved. This is technically demanding and requires familiarity with Ilizarov techniques. Since there was no bone loss in our cases, we decided to do supercutaneous plating as an alternative to the Illizarov fixator. However, serial debridement along with freshening of bone edges due to persistent infection resulted in excessive shortening in one patient. To reduce the risk of knee stiffness, the patients were put on a CPM device in the early post-operative period. Despite this, some loss of knee flexion is inevitable. This loss can be partly attributed to quadriceps scarring due to infection and surgical trauma, but the fact that the fracture healed in all cases with subsidence of infection warrants further evaluation of this technique in such difficult situations. To the best of our knowledge, no other reports have described the use of this technique for femur fractures. Qiu et al. in their study reported the average union time of 21.2 weeks in proximal tibial fractures with compromised soft tissue [7]. The union time

Table 2: Time for union, knee society score and complication

| S. No. | Time for union | Knee society score | Complications |
|---|---|---|---|
| 1 | 4 months | Excellent | 0.5 cm shortening pin tract infection |
| 2 | 3 1/2 month | Good | 1 cm shortening Pin tract infection |
| 3 | 4 month | Good | 1 cm shortening pin tract infection |
| 4 | 9 months | Fair | 2 cm shortening refracture, pin tract infection |
| 5 | 8 months | Poor | 5 cm shortening pin tract infection |
| 6 | 3 months | Excellent | Nil |
| 7 | 4 months | Excellent | Nil |
| 8 | 3 1/2 month | Good | 1.5 cm shortening |
| 9 | 4 months | Good | 2 cm shortening Pin tract infection |
| 10 | 4 months | Good | 1 cm shortening |
| 11 | 8 months | Fair | 1.5 cm shortening |
| 12 | 4 months | Good | Nil |
| 13 | 5 months | Excellent | 1 cm shortening |
| 14 | 4 month | Good | 1 cm shortening |
| 15 | 7 months | Fair | 2 cm shortening |

in our series with tibia fractures was shorter (average 19 weeks) despite the presence of local infection at the time of presentation. This could be because we dynamized the construct by gradually removing the screws and allowed the patients to weight bear while mobilizing as the union progressed. One patient (segmental femur fracture) sustained a refracture 4 weeks after the removal of the plate. This was probably a misjudgment on the part of the treating doctor, as there was inadequate callus on the medial side.

There were no intraoperative or early post-operative complications. As compared to other studies, the incidence of screw track infection, as evidenced by pain, redness, and discharge around the screw, was higher in our study [17, 18,19]. This may be due to the presence of preexisting infection in our series. The infection rate could have been lower with the use of a titanium plate screw construct [8, 12]. None of these infections needed screw removal before the stipulated time and subsided with short-course antibiotic therapy.

### Limitations of the study

We acknowledge some limitations of our study. The number of cases is small, and there was no control group. Although none of the cases needed revision of fixation, we did not do a cost analysis in this study, and therefore, no claim should ideally be made regarding the cost-effectiveness of locking plate external fixators as compared to other treatment methods. The drawback of locking plates over the limb reconstruction system or the Illizarov is that shortening cannot be addressed. Finally, the locking plates are not designed to be used as an external fixator, and with the limited quality evidence available, a comparison with established methods might not be appropriate.

## Conclusion

Consistent, good radiological and clinical outcomes can be achieved using LCP external fixators a definitive fixation modality in selected cases of open lower limb fracture complicated with infection. The procedure is well tolerated by patients and provides adequate stability until bone union. There were relatively low overall costs because there was no need for a second operation to remove the plate, and the old plates can be reused. However, the large-scale prospective clinical study is warranted to verify our results. The present study describes a useful alternative for the treatment of these challenging cases of infected lower limb fractures and the basis for future research.

**Clinical Message**

Locking plate external fixators offer a practical, cost-effective, and stable alternative in managing infected, extra-articular long bone fractures without bone loss. With proper patient selection and technique, this method can lead to favorable outcomes even in complex cases.

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil **Source of support:** None

## References


1. Diwan A, Eberlin KR, Smith RM. The principles and practice of open fracture care 2018. Chin J Traumatol 2018;21:187-92.

2. Cross WW 3rd, Swiontkowski MF. Treatment principles in the management of open fractures. Indian J Orthop 2008;42:377-86.

3. Paley D, Herzenberg JE. Intramedullary infections treated with antibiotic cement rods: Preliminary results in nine cases. J Orthop Trauma 2002;16:723-9.

4. Ajmera A, Verma A, Agrawal M, Jain S, Mukherjee A. Outcome of limb reconstruction system in open tibial diaphyseal fractures. Indian J Orthop 2015;49:429-35.

5. Atef A, El-Tantawy A. Management of open infected comminuted tibial fractures using Ilizarov concept. Eur J Orthop Surg Traumatol 2014;24:403-8.

6. Kloen P. Supercutaneous plating: Use of a locking compression plate as an external fixator. J Orthop Trauma 2009;23:72-5.

7. Qiu XS, Yuan H, Zheng X, Wang JF, Xiong J, Chen YX. Locking plate as a definitive external fixator for treating tibial fractures with compromised soft tissue envelop. Arch Orthop Trauma Surg 2014;134:383-8.

8. Tulner SA, Strackee SD, Kloen P. Metaphyseal locking compression plate as an external fixator for the distal tibia. Int Orthop 2012;36:1923-7.

9. Zhang J, Ebraheim N, Li M, He X, Liu J, Zhu L, et al. External fixation using femoral less invasive stabilization system plate in tibial proximal metaphyseal fracture. Clin Orthop Surg 2015;7:8-14.

10. Zhou Y, Wang Y, Liu L, Zhou Z, Cao X. Locking compression plate as an external fixator in the treatment of closed distal tibial fractures. Int Orthop 2015;39:2227-37.

11. Ma CH, Wu CH, Jiang JR, Tu YK, Lin TS. Metaphyseal locking plate as an external fixator for open tibial fracture: Clinical outcomes and biomechanical assessment. Injury 2017;48:501-5.

12. Xiao C, Tang F, Zhou Y, Zhang W, Luo Y, Duan H, et al. A locking compression plate as an external fixator for treating infected nonunion of the humeral diaphysis. BMC Surg 2016;16:53.

13. Sirisreetreerux N, Sa-Ngasoongsong P, Chanplakorn P, Kulachote N, Laohajaroensombat S, Suphachatwong C, et al. Using a reconstruction locking compression plate as external fixator in infected open clavicle fracture. Orthop Rev (Pavia) 2013;5:52-5.

14. Ang BF, Chen JY, Yew AK, Chua SK, Chou SM, Chia SL, et al. Externalised locking compression plate as an alternative to the unilateral external fixator: A biomechanical comparative study of axial and torsional stiffness. Bone Joint Res 2017;6:216-23.

15. Liu W, Yang L, Kong X, An L, Hong G, Guo Z, et al. Stiffness of the locking compression plate as an external fixator for treating distal tibial fractures: A biomechanics study. BMC Musculoskelet Disord 2017;18:26.

16. Zhang JW, Ebraheim NA, Li M, He XF, Schwind J, Zhu LM, et al. Distal tibial fracture: An ideal indication for external fixation using locking plate. Chin J Traumatol 2016;19:104-8.

17. Zhang J, Ebraheim NA, Li M, He X, Liu J, Zhu L, et al. External fixation using a locking plate: A reliable way in treating distal tibial fractures. J Orthop Trauma 2015;29:e454-8.

18. Halawi MJ, Morwood MP. Acute management of open fractures: An evidence-based review. Orthopedics 2015;38:e1025-33.

19. Parameswaran AD, Roberts CS, Seligson D, Voor M. Pin tract infection with contemporary external fixation: How much of a problem? J Orthop Trauma 2003;17:503-7.


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